REM Sleep Monitor II

SD1301

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Introduction

- Detect REM sleep using EOG signals
- Communicate to the user that they are in REM sleep
- Induce lucid dreaming
- Develop a cost effective monitor
- Make design accessible to the public
- Potential Applications

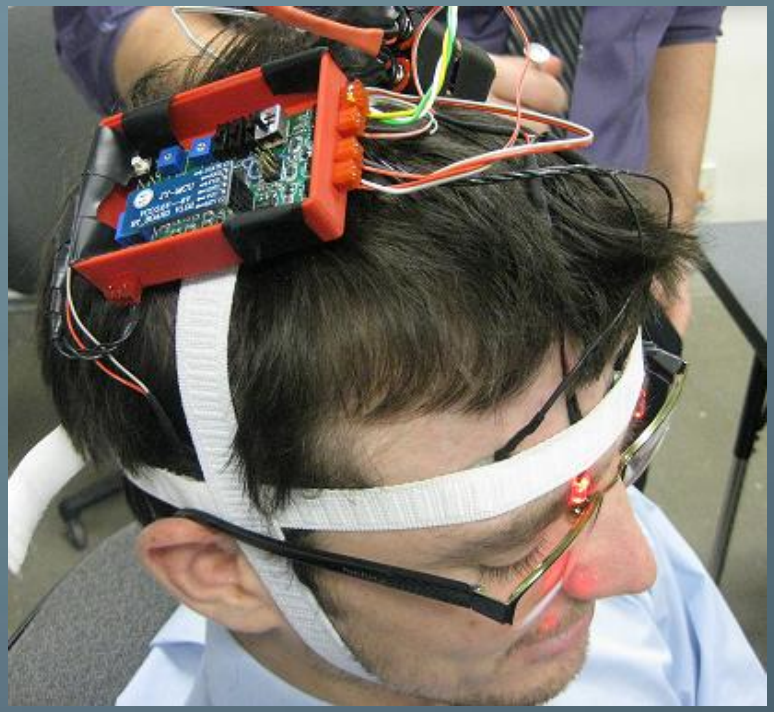
Objectives

- Improve previous hardware
- Improve previous software
- Include configurations such as:
  - Alerting the user while dreaming
  - Wake the user during REM sleep or when REM is complete
- Improve comfort of the device headband
- Minimize cost
- Make design process easy for general public to recreate

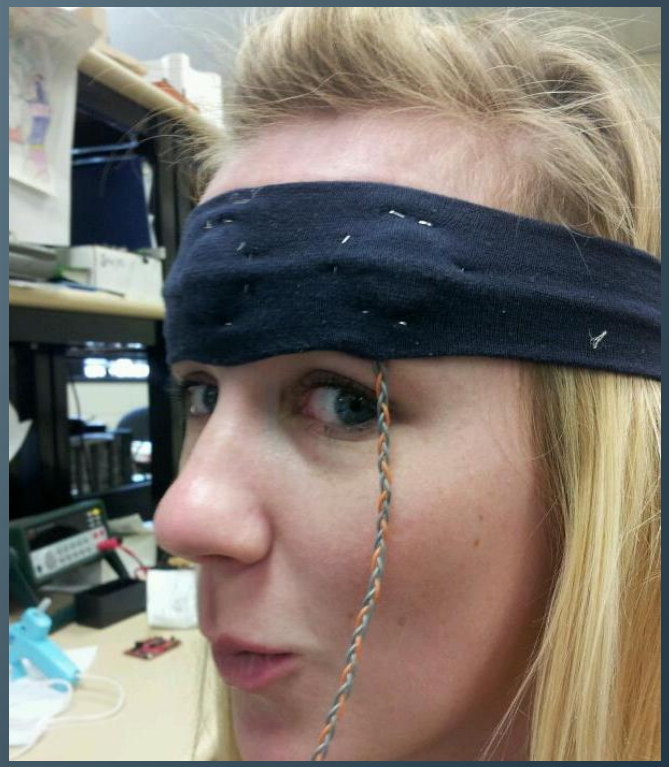
Requirements

- Ability to be tested and be verified
- Accurately detect REM sleep
- Send cue to user during REM and after REM
- Transmit information via Bluetooth to computer to be stored
- Battery operated
- Compact and non-invasive
- Acquire IRB approval
- Meet AASM standards

Headband & Electrodes



Previous design



Current design

Headband & Electrodes

- 28 gage stranded wire
- 100% silver fabric
- Furniture sliders
- Velcro
- Hot glue
- Speakers
- Staples

Methods of Alerting

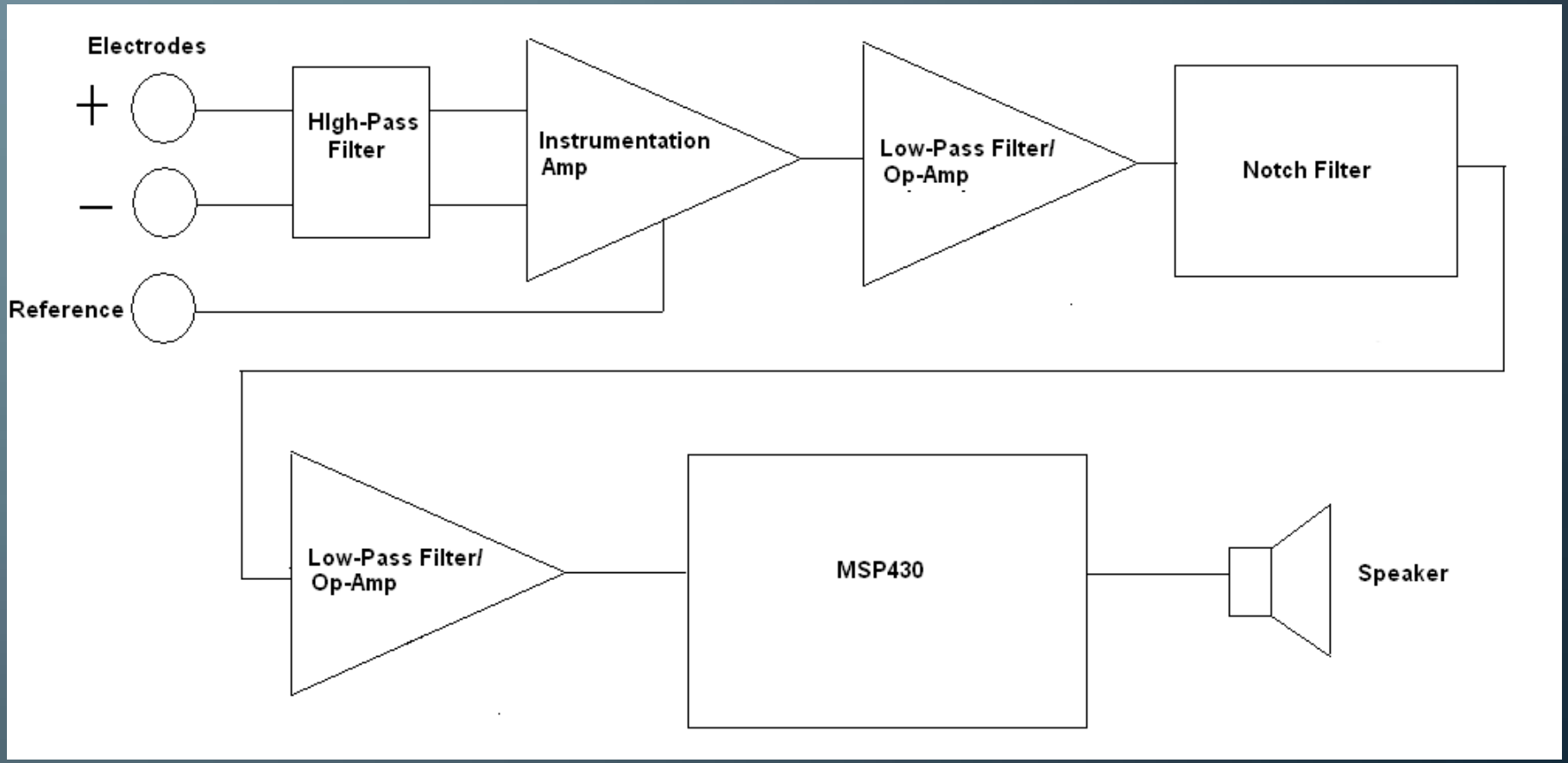
LED

Motor

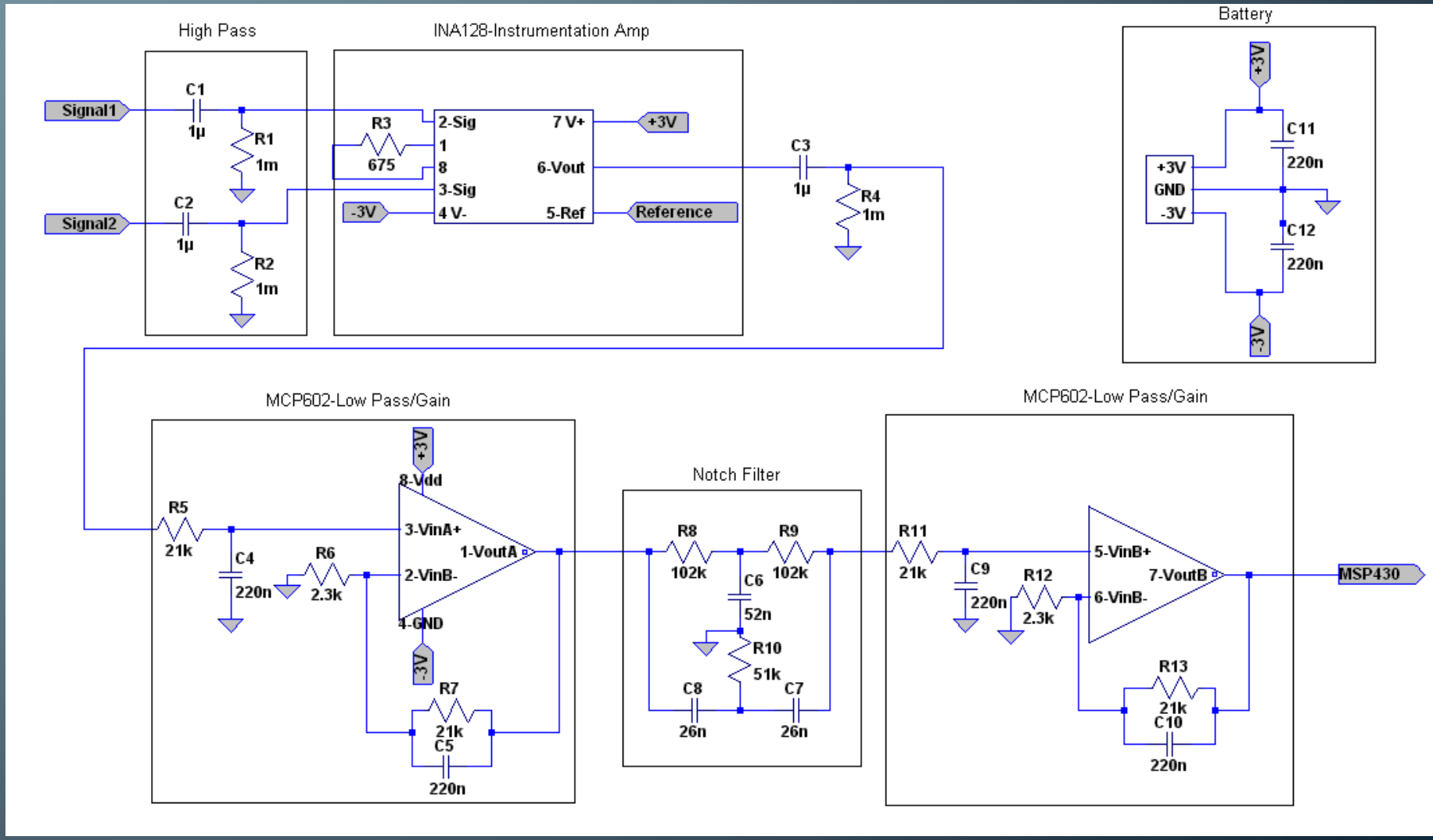
Speaker

Piezoelectric Speaker

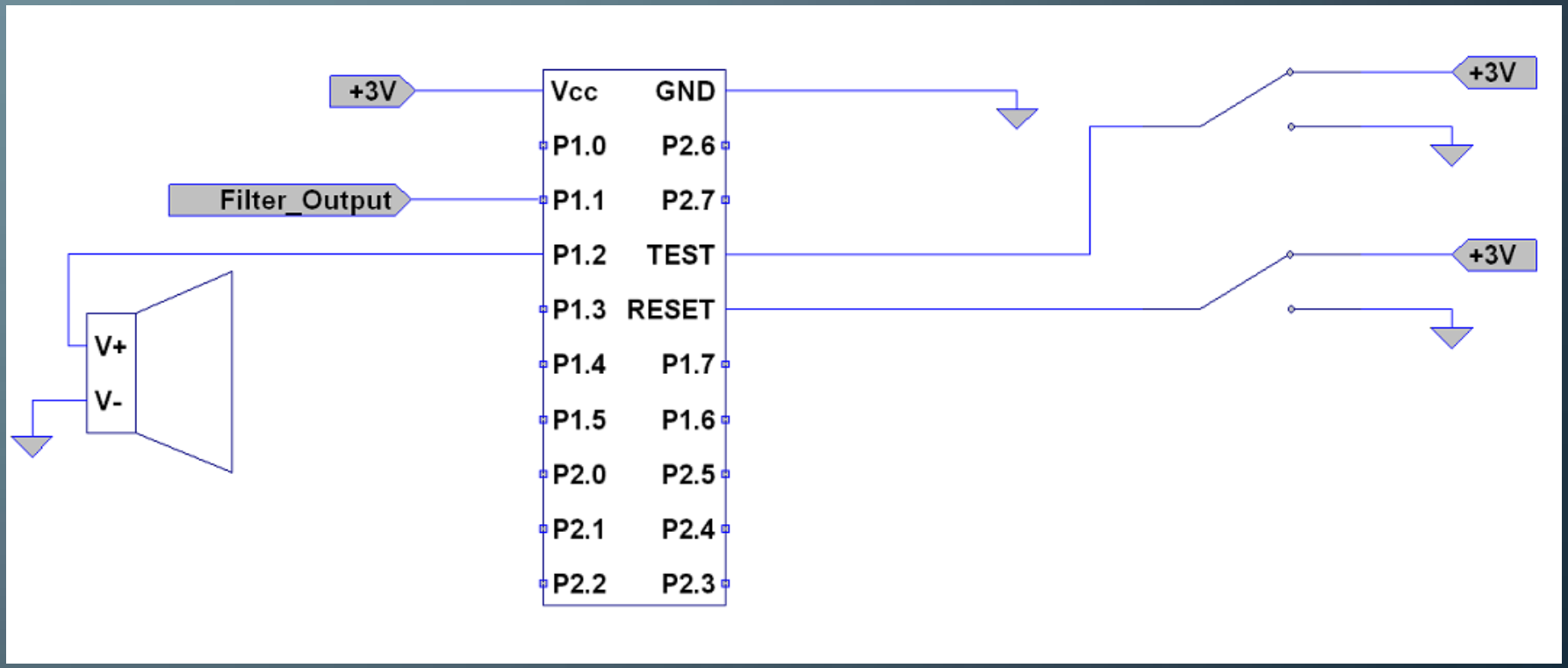
Block Diagram



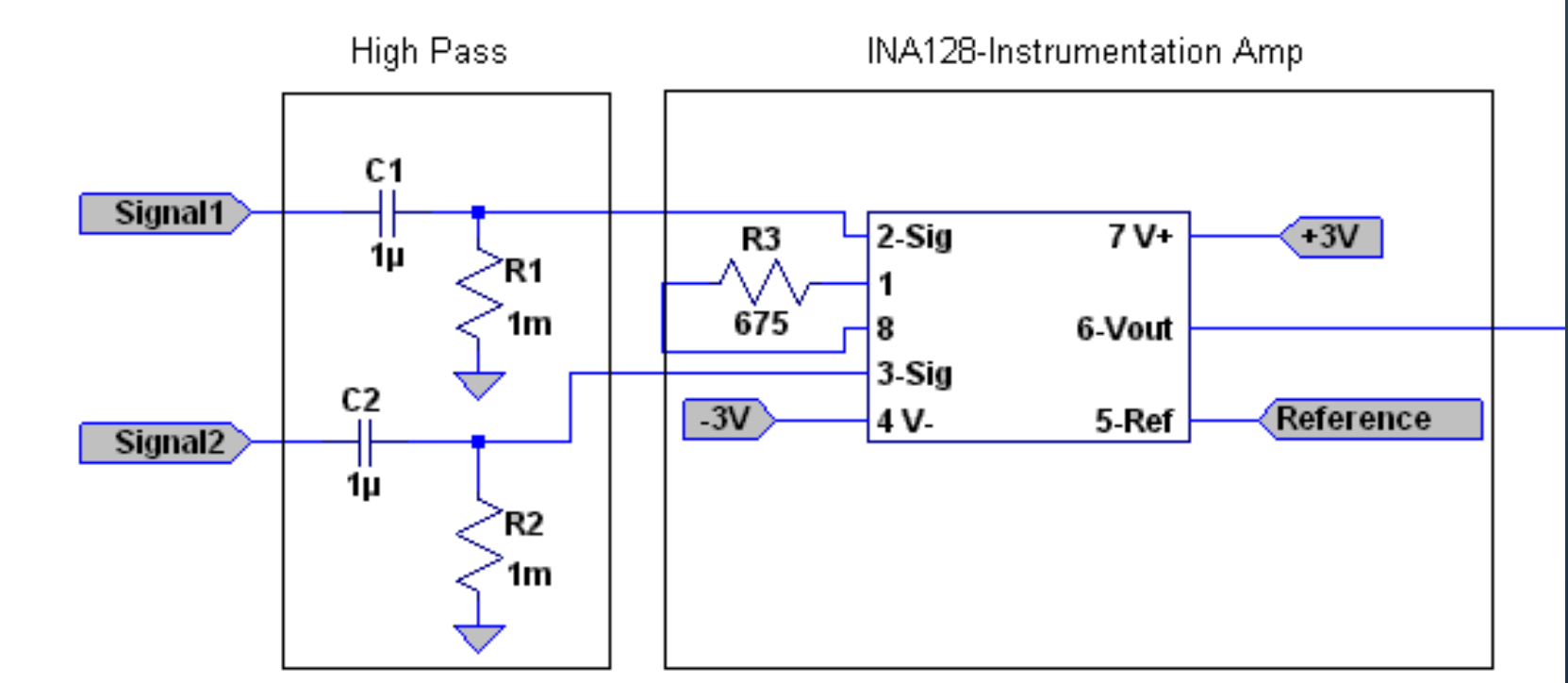
Schematic


High Pass
INA128-Instrumentation Amp
Battery
Signal1
Signal2
C1
1µ
C2
1µ
R1
1m
R2
1m
R3
675
2-Sig
1
8
3-Sig
4 V-
7 V+
6-Vout
5-Ref
+3V
-3V
Reference
C3
1µ
R4
1m
+3V
GND
-3V
C11
220n
C12
220n
MCP602-Low Pass/Gain
MCP602-Low Pass/Gain
8-Vdd
3-VinA+
2-VinB-
1-VoutA
4-GND
R5
21k
C4
220n
R6
2.3k
R7
21k
C5
220n
Notch Filter
R8
102k
R9
102k
C6
52n
R10
51k
C8
26n
C7
26n
R11
21k
C9
220n
R12
2.3k
5-VinB+
6-VinB-
7-VoutB
R13
21k
C10
220n
MSP430

MSP430 Schematic



Instrumentation Amp

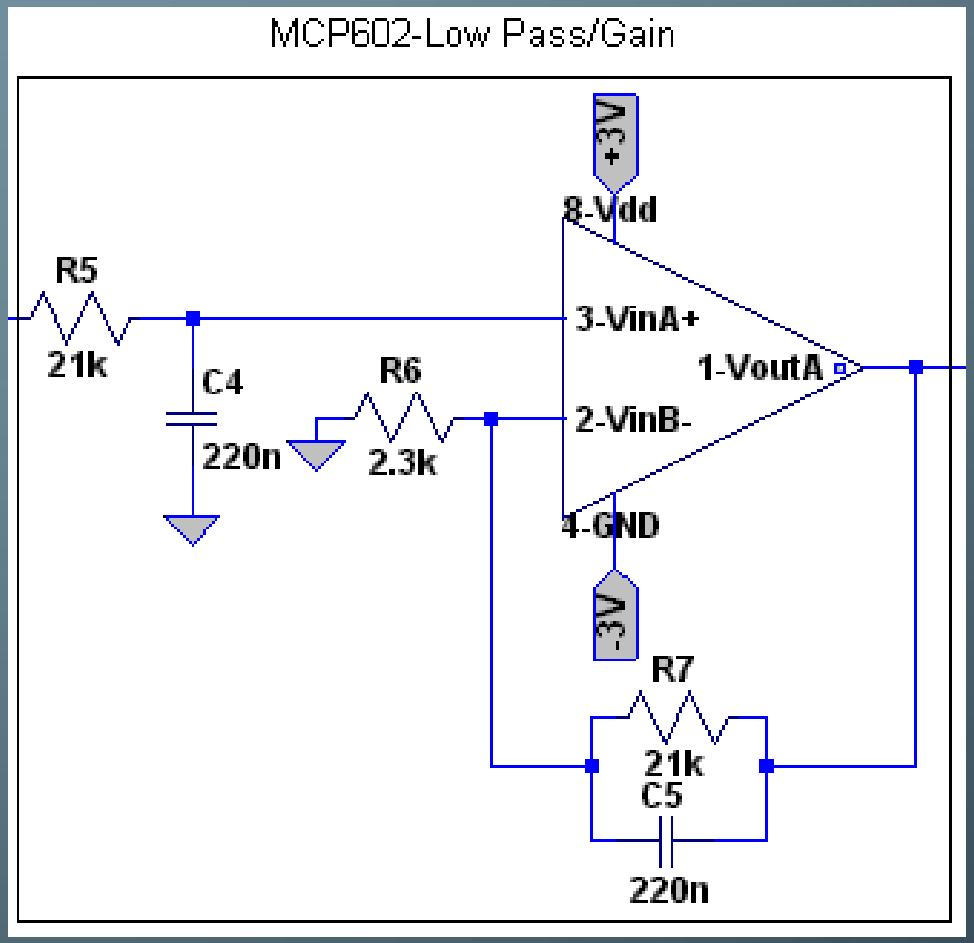


Fc=1/(2πRC) = 0.159Hz

CMRR=120dB

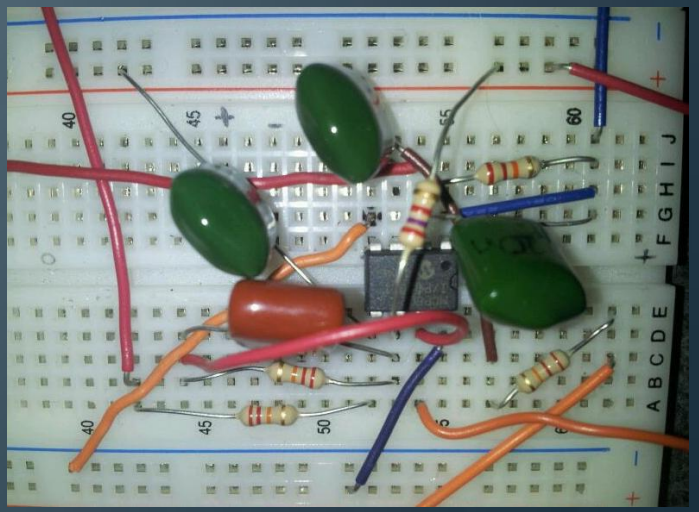
Gain=1+50k/Rg = 75

Low Pass Filter/Amplifier

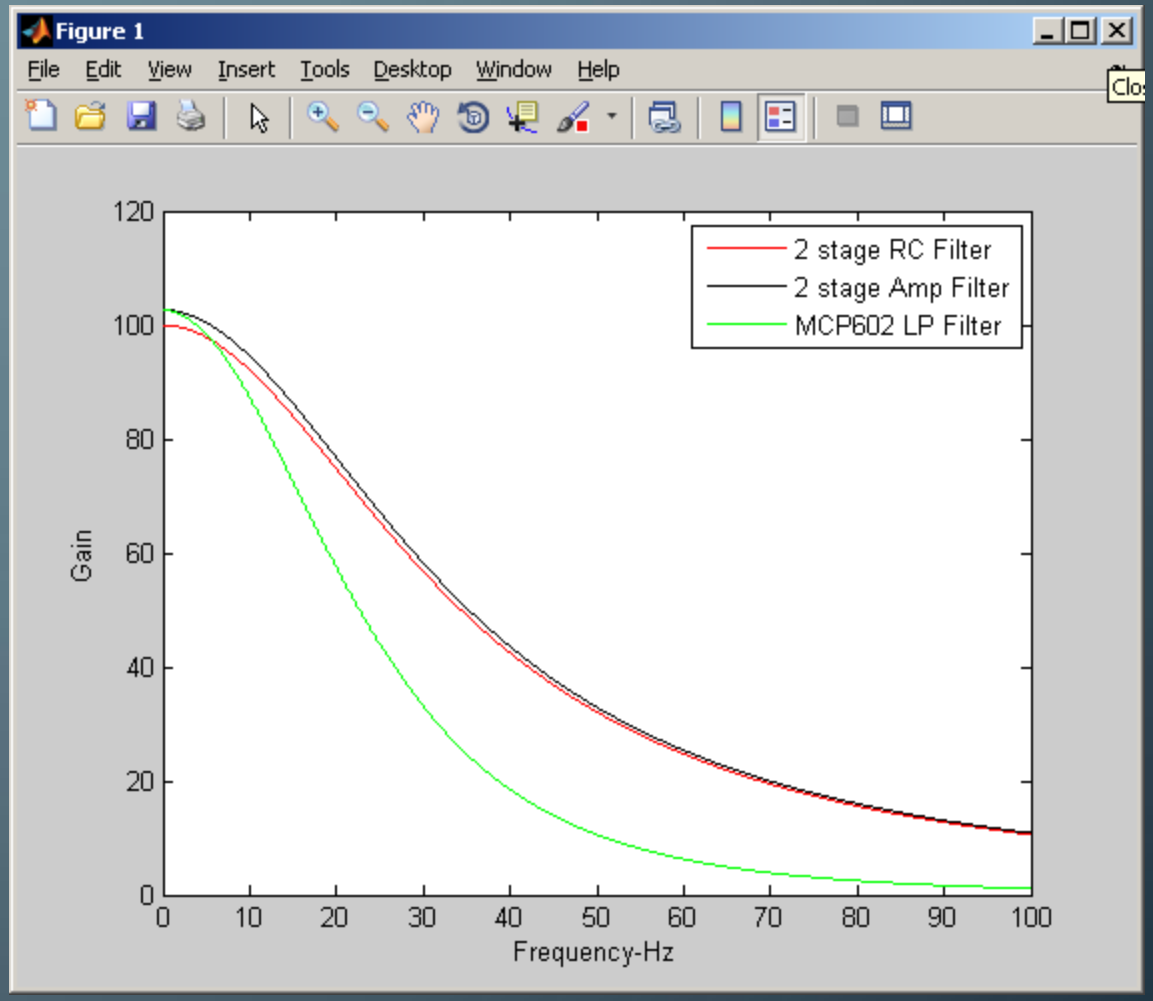


Fc=1/(2πRC)=35Hz

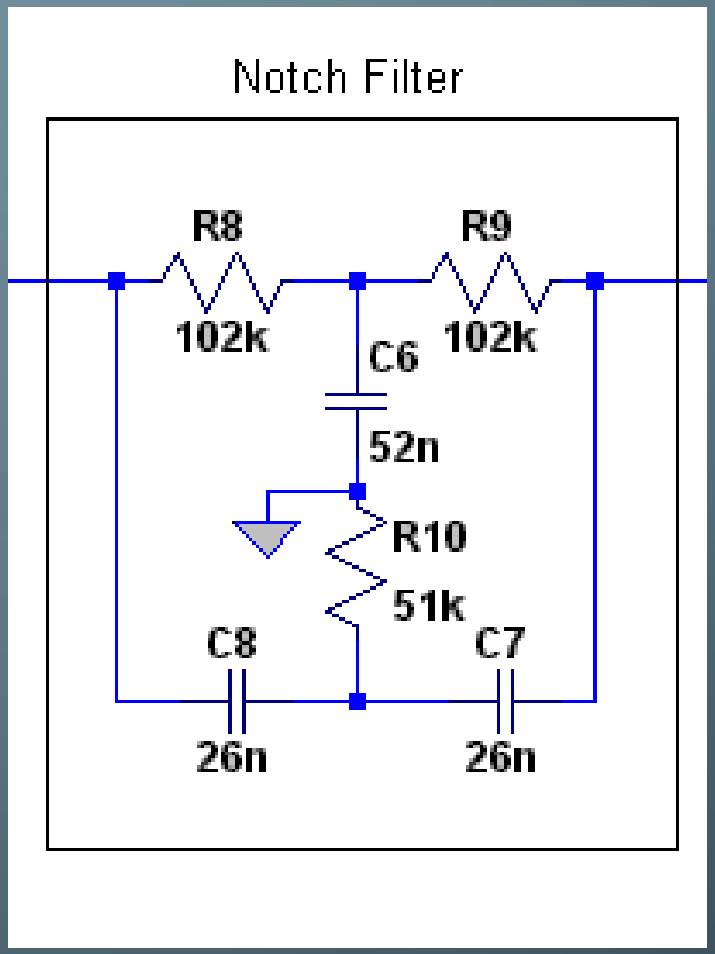
Gain=1+R2/R1=10.13



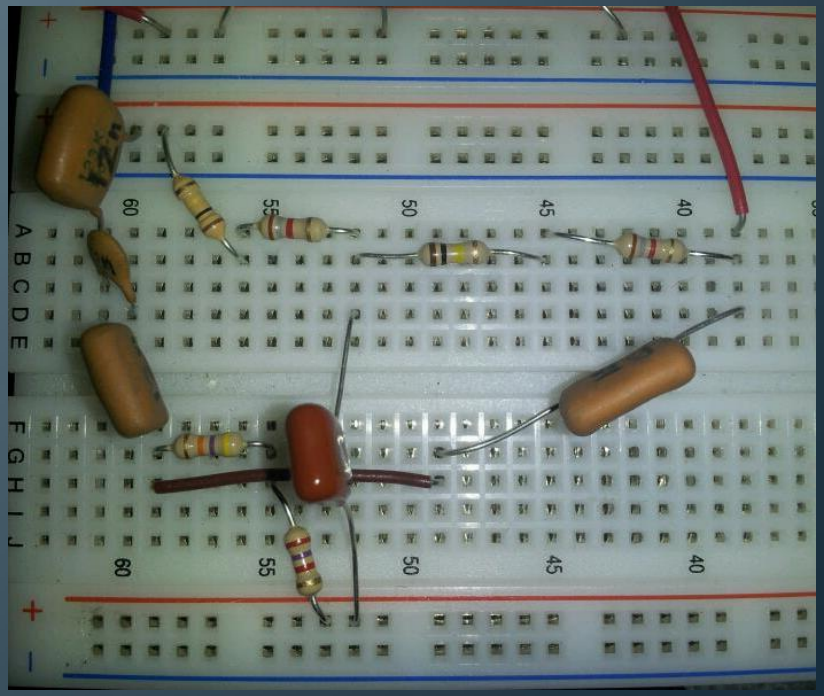
Low Pass Filter/Amplifier



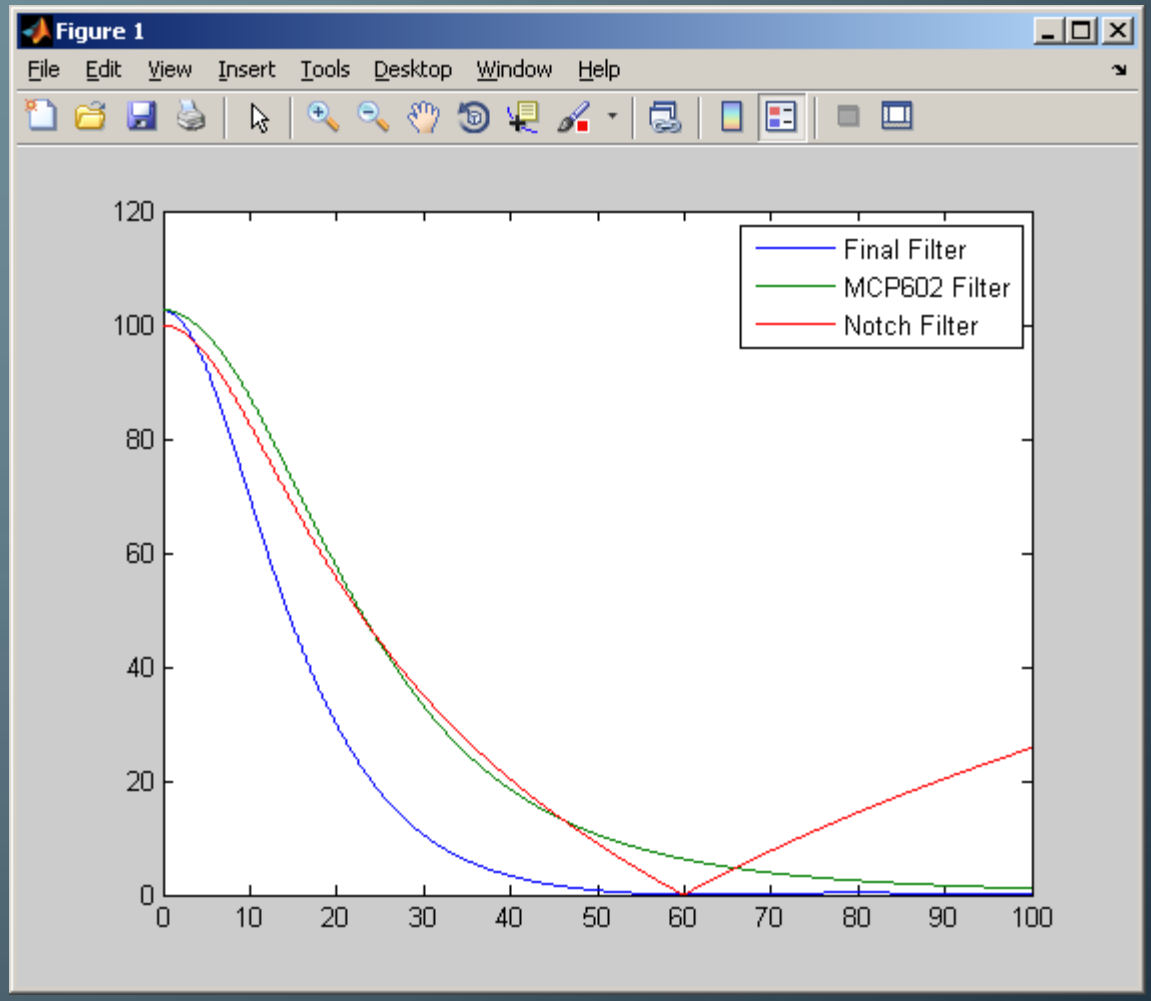
Notch Filter



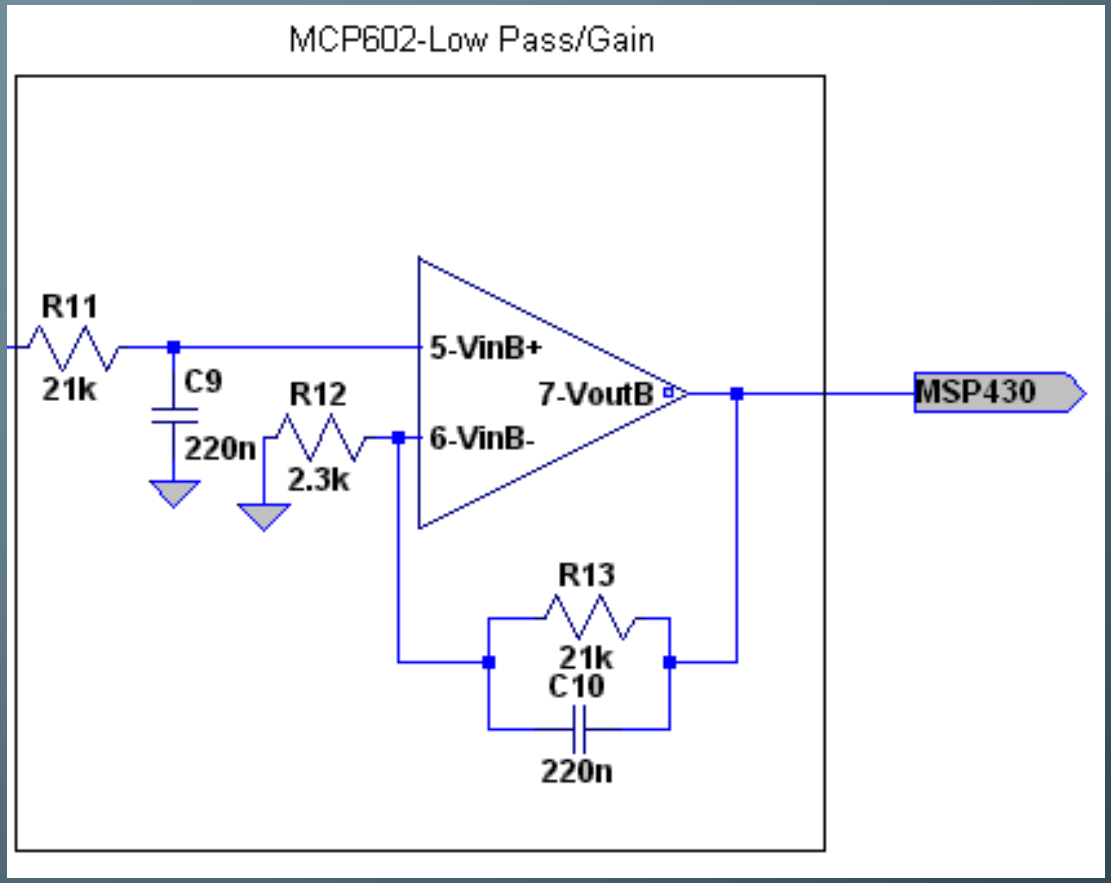
Fc=1/(2πRC)=60Hz



Notch Filter



Low Pass Filter/Amplifier



Fc=1/(2πRC)=35Hz

Gain=1+R2/R1=10.13

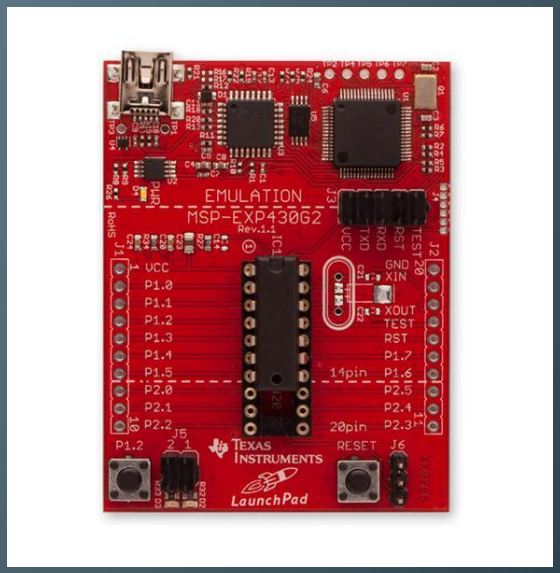
Testing

Microcontroller

ATmega328

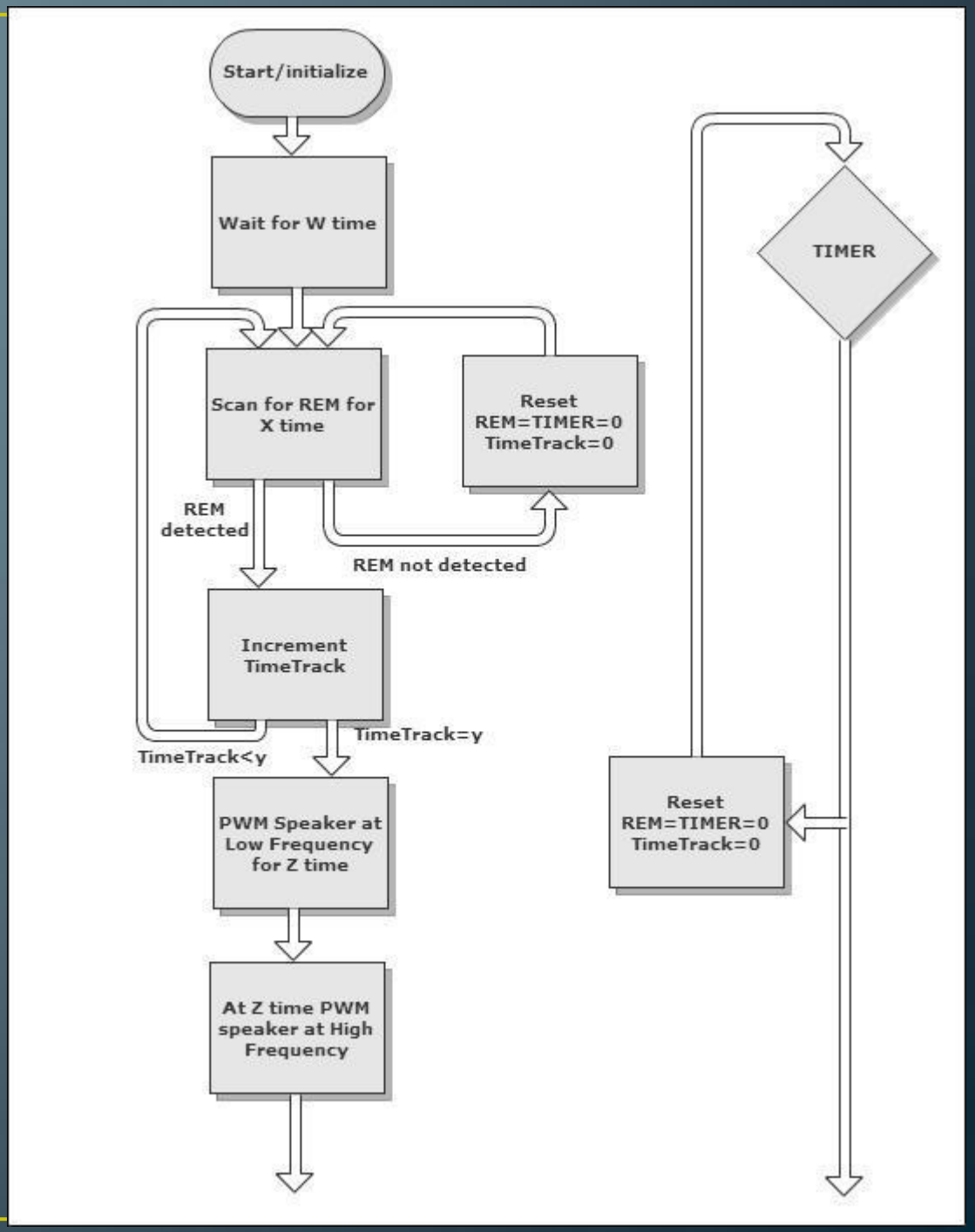
- Used by previous group

MSP430

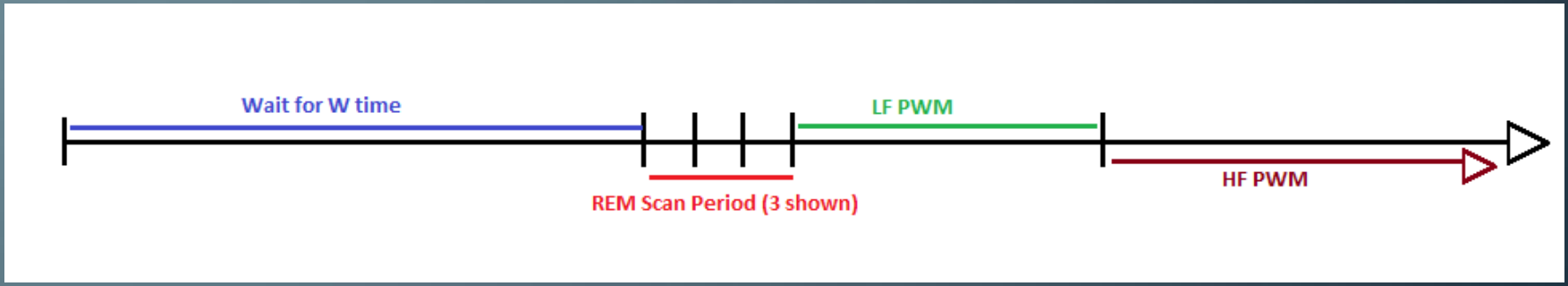


- Previous experience
- Common in medical applications
- Low power consumption
- Sleep mode

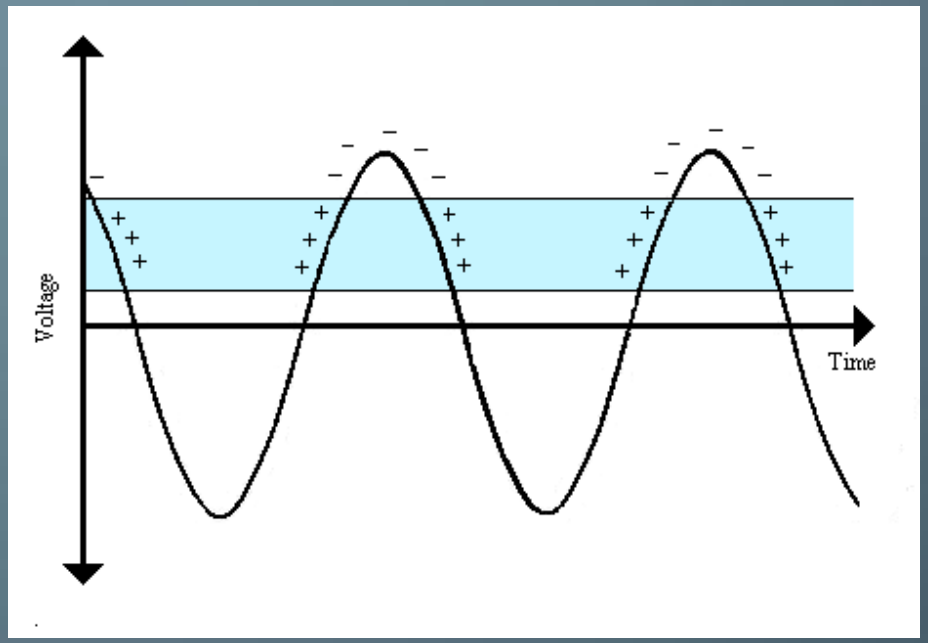
Software Block Diagram



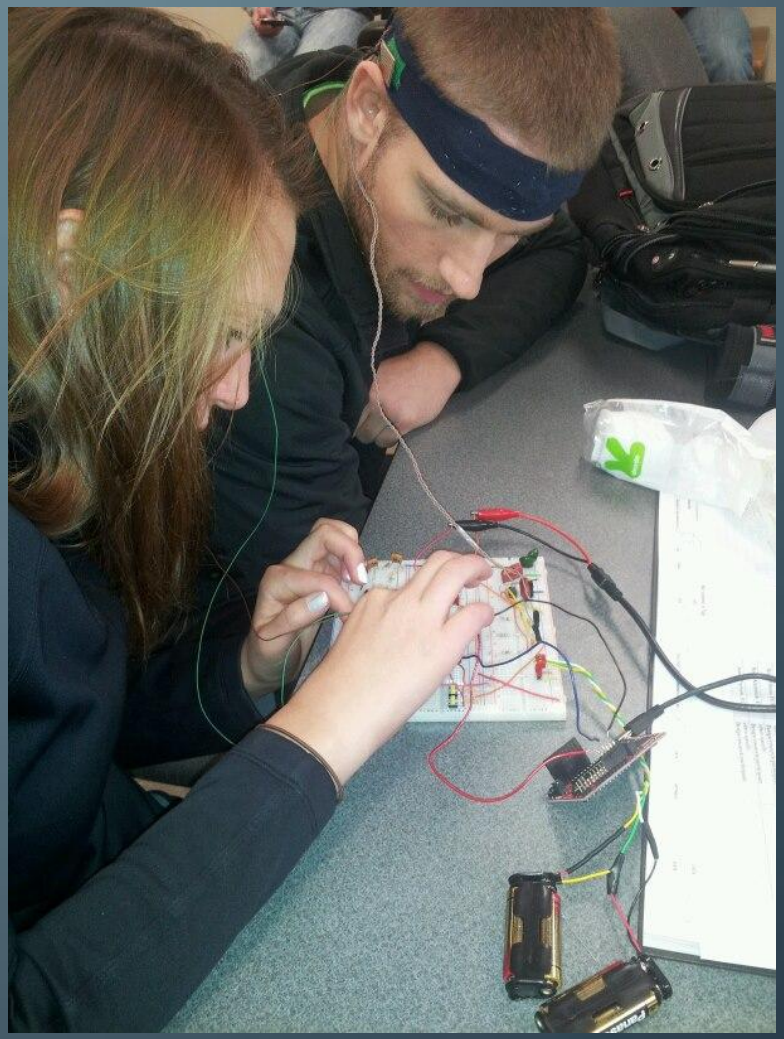
Code Timeline



Software - REM Detection



Verification



IRB Approval

- Certification
- Documentation
- FDA components approval

Budget

PURCHASED					
Item	**Part Number/Type**	**Retail Cost /Unit**	**Acquired Cost /Unit**	**Quantity**	**Total Cost**
Piezoelectric Speaker	668-1266-ND	$5.38	$5.38	4	$21.52
Low Profile Speaker	CDMG16008-03-ND	$2.51	$2.51	1	$2.51
Goody Headbands	-	$3.00	$0	2	$0
Panasonic Batteries	C1500B4N	$4.99	$0	1	$0
Silver Conductive Fabric	1167	$9.95	$9.95	1	$9.95
Stainless Conductive Thread	603	$5.95	$5.95	1	$5.95
MSP430-Launch Pad Dev. Kit	296-27570-ND	$10.37	$10.37	2	$20.74
MSP430G2553IN20	595-MSP430G2553IN20	$2.25	$2.25	5	$11.25
INA128	INA128PA-ND	$8.33	$0	1	$0
ATmega328	ATMEGA328-PU-ND	$2.88	$2.88	2	$5.76
Total					**$77.68**

Budget

REMAINING PURCHASING					
Item	**Part Number/Type**	**Retail Cost /Unit**	**Acquired Cost /Unit**	**Quantity**	**Total Cost**
Miscellaneous components	-	$30	-	-	$30.00
PCB	-	$50	-	1	$50.00
3-D Printing	-	$10	-	1	$10.00
Bluetooth Transmitter	-	$10.00	-	5	$50.00
Bluetooth Receiver (USB)	-	$5.00	-	5	$25.00
INA128	INA128PA-ND	$8.33	-	2	$16.66
Piezoelectric Speaker	668-1266-ND	$5.38	-	4	$21.52
Goody Headbands	-	$3.00	-	1	$3.00
Velcro		$5.47	-	1	$5.47
Panasonic Batteries	C1500B4N	$4.99	-	4	$19.96
Silver Conductive Fabric	1167	$9.95	-	1	$9.95
Breadboard	-	$6.00	-	6	$36.00
Total					**$277.56**

Grand Total		**$366.00**
Estimated Budget 2/7/13		**$384.40**
Balance		**+$18.40**

Project Status

- Schematic complete
- Initial code complete
- Circuit breadboarded and tested
- Electrodes and headband complete
- Eye movements detected and verified
- Updated Wiki
- IRB in progress

Timeline - Spring 2013

SEMESTER	WEEK	DATE	EVENTS	PROJECT DEADLINES	Assigned To:
Spring	1	7-Jan		*Learn about various senior design project opportunities*	All
Spring	2	14-Jan		*Meet with group members and advisor/Research REM*	All
Spring	3	21-Jan		**Requirements Capture**	All
Spring	4	28-Jan		*Meet with Lew Daily about electrode/Analyze previous design*	James/All
Spring	5	4-Feb		**Homework #2 (design option, timeline and budget)**	All
Spring	6	11-Feb		*Work on Electrodes/Headband/Ordered parts*	All
Spring	7	18-Feb		*Work on hardware-LP Filter*	James/Alex
Spring	8	25-Feb		*Work on hardware and attend IRB informational meeting*	All
Spring	9	4-Mar		*Work on hardware-Instrumentation Amp*	Ryan/Alex
Spring	10	11-Mar	Spring Break		
Spring	11	18-Mar		*Work hardware-Improve LP Filter/Headband*	All
Spring	12	25-Mar		**Complete IRB Requirements**	James
Spring	13	1-Apr	Easter	*Work on hardware-notch filter*	Ryan/Alex
Spring	14	8-Apr		***Progress Report***	All
Spring	15	15-Apr		*Work on software/Finish Headband*	James/Britta
Spring	16	22-Apr		*Work on software/Research bluetooth*	James/Ryan
Spring	17	29-Apr	Dead Week	**Semester Presentation**	All
Spring	18	6-May	Finals		
*** Dates start on Monday of the week					

Timeline - Fall 2013

SEMESTER	WEEK	DATE	EVENTS	PROJECT DEADLINES	Assigned To:
Fall	19	26-Aug		*Work on software*	James
Fall	20	2-Sep		*Integrate bluetooth and data acquisition*	Ryan
Fall	21	9-Sep		*Work on software/Design PCB layout/Assemble Protoboards*	All
Fall	22	16-Sep		*Data collection/Analysis*	All
Fall	23	23-Sep		*Sleep Testing/Data collection*	All
Fall	24	30-Sep		*Make improvements from experiment*	All
Fall	25	7-Oct		*Sleep Testing/Data collection*	All
Fall	26	14-Oct		*Make improvements from experiment*	All
Fall	27	21-Oct		*Sleep Testing/Data collection*	All
Fall	28	28-Oct		*Make improvements from experiment*	All
Fall	29	4-Nov		*Assemble PCB and test*	All
Fall	30	11-Nov		*Design procedure for general public*	All
Fall	31	18-Nov		*Assemble PCB and test*	All
Fall	32	25-Nov	Thanksgiving	*Prep for Demo Day/Be thankful*	All
Fall	33	2-Dec		**DEMO DAY**	All
Fall	34	9-Dec	Dead Week	*Work on final presentation*	All
Fall	35	16-Dec	Finals		
	*** Dates start on Monday of the week				

Next Semester

- Power the MSP430 with +/-3V
- Recode for more robust algorithm
- Bluetooth/data acquisition
- Test on live subjects while sleeping
- Protoboards
- PCB
- Create online step by step procedure for general public

Summary

- We accomplished majority of our goals for this past semester
- Obtained a clean signal of EOG
- Completed hardware and most of the software
- IRB in process
- Increased comfort of headband/electrodes

Questions?

Thank you!